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GODDARD HANDBOOK FOR MANAGEMENT OF PROGRAMS – PROJECTS – PRODUCTS

Volume 3

Project Management

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Flight Programs and Projects Directorate



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GODDARD HANDBOOK FOR MANAGEMENT OF PROGRAMS – PROJECTS – PRODUCTS

Volume 1 – The NASA Program/Project
Environment

Volume 2 - Program Management

Volume 3 - Project Management

Volume 4 - Product Management

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VOLUME 3. PROJECT MANAGEMENT

3.0 Introduction

Every project is an element of a program—in rare cases, one project constitutes the only project of a program. GSFC projects range in size from relatively small Shuttle Attached Payloads to Explorers and ESSP-class missions to great observatories such as Hubble Space Telescope (HST). However, regardless of size, cost, complexity, or scientific or schedule priority, each project is guided and directed by the same management principles embodied in the NASA and GSFC policies, processes, procedures and guidelines. Projects shall meet all applicable requirements of NPG 7120.5 and Goddard Procedures and Guidelines (GPG's), however, these processes and procedures can be tailored to the specific project's need, NASA program authorization and direction, and GSFC management's implementation of the project. Volume 3 of this Handbook emphasizes NPG 7120.5 Project requirements and guidelines; Volume 4 concentrates on the GSFC QMS GPG requirements, particularly those necessary for ISO 9001 compliance for GSFC products and services provided to customers. Therefore, all products and services within scope of the GSFC QMS, which includes those of flight programs and projects and elements thereof, must be compliant with GSFC QMS product requirements.

Every GSFC directorate supports the project management process, including the following contributions:

- Office of the Director (Code 100) - Center executive management, Office of the Chief Counsel, the Chief Financial Officer, the Human Resources Office (HRO) functions, and participation in all Provide Aerospace Products and Capabilities (PAPAC) Subprocesses.
- Management Operations Directorate (Code 200) - Institutional support, including procurement, security, facilities management and personnel safety.
- Office of Flight Assurance (Code 300) - Centralized performance assurance and quality assurance functions, including performance analysis and reliability consultation, and strong participation in the PAPAC Evaluation subprocess.
- Flight Programs and Projects Directorate (Code 400) - Flight Project planning and management, including support to the PAPAC Formulation, Evaluation and Approval subprocesses; Implementation subprocess leadership, specific guidance and direction in management, and project-unique institutional support.
- Applied Engineering and Technology Directorate (Code 500) – Goddard-wide applied engineering, discipline support, and technology development.
- Space Sciences Directorate (Code 600) - Space science research, including planning, science management and direction, and development of selected instruments or sensors.
- Systems, Technology, and Advanced Concepts Directorate (Code 700) - Advanced technology and systems engineering, Access to Space (ATS), and PAPAC Formulation Subprocess leadership.
- Suborbital Projects and Operations Directorate (Code 800) - Sub-orbital, Shuttle (and potentially Space Station) Attached Payload, balloon flight, research aircraft and sounding rocket planning, management, support and execution.
- Earth Sciences Directorate (Code 900) - Earth science research, including planning, science management and direction, and development of selected instruments or sensors.

A project is an activity designated by a program and characterized as having defined goals, objectives, requirements, LCC's, and a beginning and an end. The minimum required documents for NPG 7120.5 project compliance are the following:

- Program Commitment Agreement
- Program Plan (which includes the specified project)
- Project Plan (authorized by specific inclusion in the Program Plan)

3.1 Goddard Project Environment

3.1.1 GSFC Organization: Reengineered Roles

Led by NASA's Administrator, NASA Headquarters made a number of organizational and management changes to facilitate the improved processes embodied in the Strategic Plan and Strategic Management Handbook. Among them was the move to establish four Strategic Enterprises and the shift of the Program Manager and most Program Scientist roles to NASA Field Centers. This shift improves the Field Centers' abilities to respond to their customers – the NASA Strategic Enterprises, the public, and other specific entities.

In concert with the NASA Headquarters' reorganization into Strategic Enterprises and program-level responsibilities at Field Centers, GSFC responded with an extensive reorganization to align with the key Strategic Enterprise activities for which it is responsible. Therefore, many traditional roles at GSFC changed, such as the emergence of new directorates: the System Technology and Advanced Concepts (STAAC) Directorate and the Applied Engineering and Technology Directorate (AETD). Generally, STAAC takes the leading role in Project Formulation and Approval, while the Flight Programs and Projects Directorate (FPPD) supports Project Formulation and generally leads Goddard's Project Implementation, with the exception of those delegated to the Suborbital Projects and Operations Directorate (ref. Volume 2, Para. 2.3.1). FPPD, AETD, and the Science directorates share a partnering role in the Approval activities to ensure continuity and project success. The Science directorates, STAAC, and AETD support the project during Formulation and Implementation, providing necessary science and engineering leadership.

3.1.2 Development of a Project

A project is an organization established to assemble a mission and integrate a set of goals and objectives. The development of a project proceeds Pre-formulation, then through the PAPAC subprocesses of Formulation, Approval, Implementation and Evaluation. Evaluation is ongoing throughout the development of a project.

Missions concepts developed at GSFC vary in definition and maturity. In all cases, it is necessary to understand the commitment of resources the Center is making in supporting each customer. Achieving this understanding may require developing feasible mission concepts, in Pre-formulation, supporting New Business Committee (NBC) briefings, formulating a specific project, or developing a specific proposal in response to an AO. This support will be provided to the customer by identifying a Project Formulation Manager (PFM) who acts as the lead for Pre-formulation, project formulation, and potentially proposal development. It is the policy of GSFC to provide continuity of key personnel throughout definition, design, and development whenever possible. Based on the recommendation of the Chief of the Project Formulation Office, appointments of PFM's will be made jointly by the Directors of STAAC and the Director of Flight Programs and Projects Directorate (FPPD), with the concurrence of the Program Manager and the customer. Instrument Manager (IM), appointments will be by the Flight Instrument Development Office, and will require concurrence of the Chief, Mission Integration Planning Division, and the customer.

Missions may enter Pre-formulation through one of several methods. An Enterprise directed mission enters Pre-formulation immediately. Innovative Concept Development (ref SED PG) occurs within the Systems Engineering Division of the STAAC. Concepts with sufficient majority are presented to the Pre-formulation for approval to enter Pre-formulation. Customers may also bring mission concepts directly to the NBC for approval to enter Pre-formulation

An Enterprise-directed mission is formulated at the request of some element of an Enterprise with the expectation of funding via a new start in the POP process. These missions do not compete for

funding via an AO, although project elements such as investigations may be competed and funded by a mission-unique AO. The mission is integrated into a program as a project after source selection. A PFM manages the development. These missions may be undefined at the beginning of formulation and thus require a lengthier and more extensive process than the typical competed mission. The AETD and the System Engineering Division (SED) within STAAC support both types of missions for system and discipline and system engineering. A further discussion of directed and missions can be found in Supplemental Volume 5 of this Handbook.

PROGRAM/PROJECT LIFE CYCLE OVERVIEW

Within the Provide Aerospace Products and Capabilities (PAPAC)

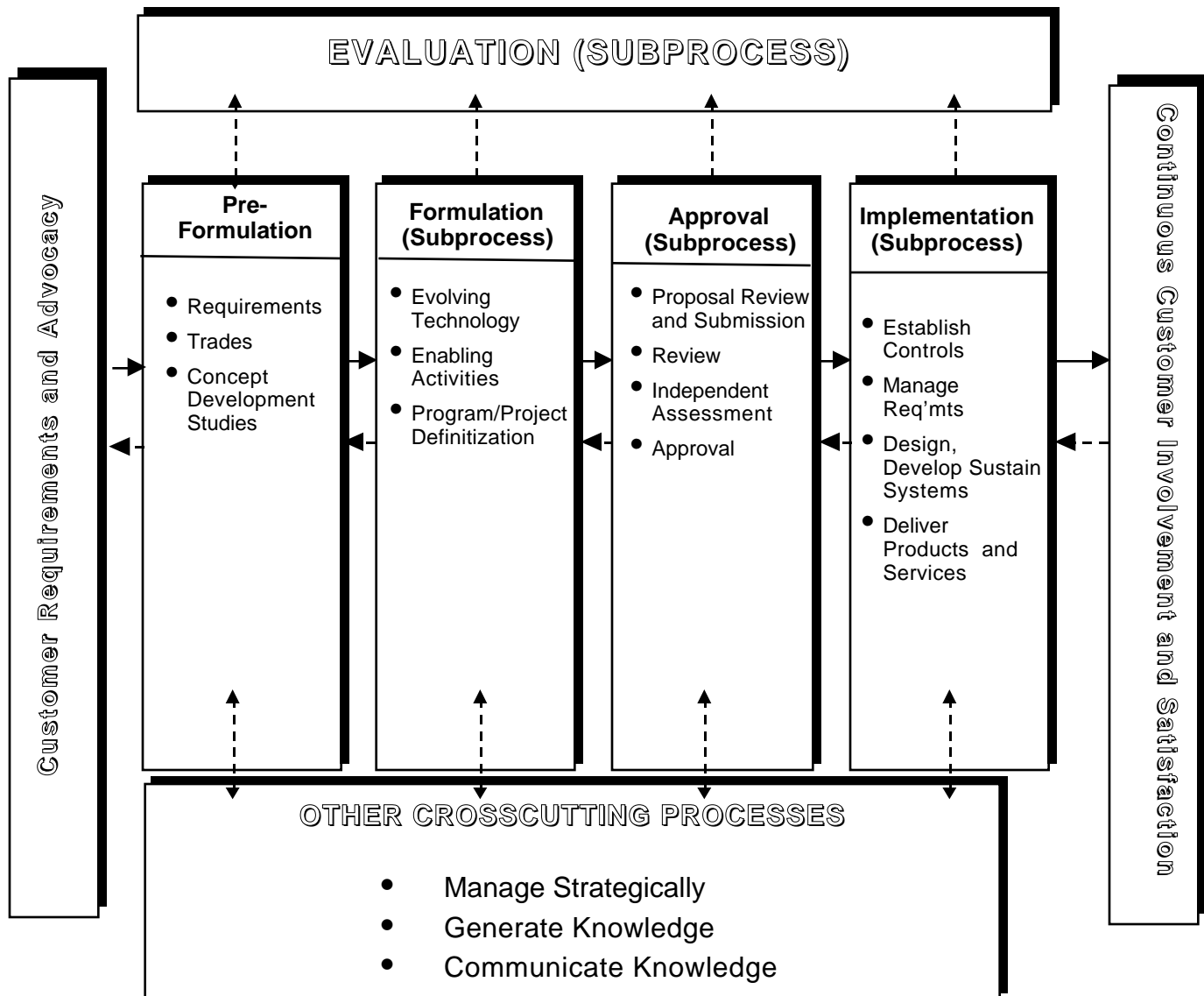


Figure 3-1: Program/Project Life Cycle Overview

3.1.2.1 Pre-formulation

Pre-formulation concept development and the subsequent formulation of a new project at GSFC is a customer-focused, seamless process, managed in accordance with GPG 7120.2. Pre-formulation begins with a customer's suggested science and/or technical concept. Through the leadership of a PFM, the concept gains the GSFC support required to pursue the formulation of a project and its subsequent implementation. The key steps are displayed in Figure 3-2 and described in the subsequent sections.

- 🌀 Assign team to develop a feasible mission concept
- ➡ Initiate partnerships
- ➡ Develop science and/or technical requirements and mission objectives to achieve mission goal(s)
- † Define the associated option set
- ⑦ Develop preliminary mission concepts
- ⑨ Develop new roadmaps and/or mapping to existing roadmaps
- † Define the scientific or technical benefits
- † Define the opportunities to leverage research, commercialization, new technology, education
- † Prepare for the New Business Committee

Figure 3-2. Steps in Feasibility Mission Concept Development

3.1.2.1.1 Team Development When the customer approaches GSFC for support in developing Enterprise-directed feasible mission concepts, a PFM will be assigned as the manager along with the project scientist. They will review the suggested science and/or technical advanced concept and determine the team structure best suited for Pre-formulation concept development. Initial development may emphasize any or all of the following:

- Systems Engineering
- Specific Engineering Disciplines
- Enabling Technologies including Demonstrated Technologies/Advanced Technologies
- Evolutionary Concepts
- Revolutionary Concepts
- Instrument Focus
- Spacecraft Focus
- Ground Systems Focus
- Urgency and Priority

Determination of the emphasis will drive the initial structure of the concept team. Members of the concept team should be individuals who are comfortable in a dynamic visionary environment that may demand a rapid evolution of ideas and involvement with senior management at GSFC and with the customer. Team members are drawn from GSFC directorates as required.

In this volume, for the purpose of simplicity, the term PFM will be used for both PFM and IM.

3.1.2.1.2 Partnership Partnerships may develop at any time throughout the life cycle of the project. These may develop for technical, economic, administrative, or other reasons. The emphasis of the suggested science and/or technical concept, capabilities of GSFC and its customer, and availability of technical resources may determine the need to pursue partnerships early in the development of the mission. Partnerships may be formed through competitions [e.g., a NASA Research Announcement (NRA)] or through direct contacts. The PFM and the lead scientist will approach organizations that may mutually benefit from such a relationship. These partners may be pursued based on recommendations from the customer, based on shortcomings in the GSFC experience base, or due to their leadership roles in areas critical to the mission concept. Partners may be found in government agencies, industry, or academia, either in the U.S. or elsewhere. Initial agreements will be generated to define the roles and responsibilities of the organizations during Pre-formulation. The development of strategic and national and international partnerships is conducted with the Enterprise if the agreement is signed at the Enterprise administrative level. These agreements will become the basis for agreements to support the Formulation Subprocess.

3.1.2.1.3 Development of Science Requirements and Mission Objectives Pre-formulation is initiated by an approved customer-suggested science and/or technical concept. In order to effectively support the customer's request to develop a mission concept and pursue formulation of a project, the concept team must determine the baseline science and/or technical requirements and mission objectives. These requirements and objectives will evolve throughout Pre-formulation. At completion of this process a preliminary set of requirements and objectives will be used as the basis for the Formulation Subprocess.

3.1.2.1.4 Defining the Trade Space During Pre-formulation it is important to capture all possible options that could be used in implementing the concept. The inclusive list of possible options, called the Trade Space, will become the baseline for tracking the evolution of options considered during Pre-formulation, formulation, and implementation. This baseline Trade Space with appropriate backup information will be actively maintained through completion of the project. Through this documentation, the team members will be able to determine the options considered and the basis of the decisions made regarding the options at any time in the project's life cycle.

3.1.2.1.5 Development of Preliminary Mission Concepts Using the set of requirements and objectives, the concept team will develop several preliminary mission concepts that demonstrate the feasibility of the customer's suggested science and/or technical concept. In developing these feasible mission concepts, the team will take full advantage of concept development tools, such as the Integrated Mission Development Center (IMDC), Access To Space (ATS) database, Resources Analysis Office (RAO), etc. In addition to these tools, a strong systems engineering function is an integral part of the process. Demonstration of feasible mission concepts that may meet the customer's needs is critical to gaining approval to proceed with formulation of a project.

3.1.2.1.6 Enterprise Strategic Planning Roadmaps for Science, Missions, and Technology

The customer's suggested science and/or technical concept and possible technology options to be considered may be elements of existing and Enterprise-approved NASA roadmaps. The relationship to existing roadmaps must be factored into Pre-formulation. During Pre-formulation, the concept team may need to facilitate the updating of existing roadmaps or generate and seek approval for new roadmaps to include elements of the evolving concept. These roadmaps provide the strategic basis for Enterprise-defined missions and the science focus for competed missions.

Note: Universal Resource Locators (URL's) to Strategic Plan roadmaps are identified in Appendix D.

3.1.2.1.7 Defining Scientific, Technical, and/or Economic Benefits The expected outcome of the entire process of Pre-formulation, formulation, and implementation of a project is to provide a scientific, technical, and/or economic benefit to the customer and/or the government. These benefits may be evolutionary or revolutionary in nature, but should be understood and documented within the objectives of the mission. These benefits should be stated in such a way that their applicability to government, academia, and/or industry is easily derived.

3.1.2.1.8 Defining Opportunities For Leveraging In this context, leveraging is defined as taking advantage of current and/or future activities external to the mission in order to enhance or enable the mission. In addition to the scientific and/or technical benefits that may be derived from pursuing the proposed feasible mission concept, opportunities for leveraging research, commercialization, new technology, and education must be defined. This list of opportunities for leveraging should include the area of leverage, relevant organizations and their level of involvement, level of interest and commitment, impact of the proposed concept to the opportunity, and actions required to achieve the benefits of leveraging.

3.1.2.1.9 Pre-formulation Product The product of Pre-formulation is the Project Formulation Plan. This plan defines the formulation relationships between the formulation Project, customers, partners, the Program, NASA Headquarters, GSFC organizations, and other Centers as appropriate. Also defined are the expected schedule and reporting for formulation, the expected formulation products, and the resources required to complete formulation.

3.1.2.1.10 New Business Committee (NBC) Approval Approval from the NBC to proceed to the Formulation Subprocess commits the Center to provide the necessary resources to formulate a project that meets the defined requirements and objectives. The NBC presentation documents the development methodology of the feasible mission concept process. The NBC requires that there exist, and is documented, a proposed Formulation team, proposed partnership arrangements, a preliminary set of requirements and objectives, an option set, preliminary mission concepts, a set of scientific and/or technical benefits, a mapping to existing roadmaps, and defined opportunities for leveraging research, commercialization, new technology, and education. The material presented to the NBC for approval is defined as part of the NBC process, and includes the Project Formulation Plan.

The appropriate Enterprise Associate Administrator (EAA) is responsible for Program Formulation (NPG 7120.5, paragraph 2.1.c) which is executed through a Formulation Authorization (NPG 7120.5, Appendix E-1). This form may be used for authorization of Project Formulation, consistent with the Program Plan. Authorization must occur before Formulation can begin. Responsibility for project Formulation is defined in the Program Plan (NPG 7120.5, paragraph 3.1.c) for missions assigned to a program.

3.1.2.2 Project Formulation

Projects are significant activities that have defined goals, objectives, requirements, LCC's (see NPG 7120.5, paragraph 3.1.2(f)), and a beginning and an end. Projects vary significantly in their complexity, cost, and criticality. The PFM's are responsible for the successful accomplishment of projects from Pre-formulation through Formulation and customer satisfaction with the products delivered.

The PFM is responsible for the cost, schedule, and technical performance of the project during Formulation, but there are other major responsibilities. Forming the study team, financial and acquisition management, risk management, performance management, and safety and mission assurance are critical functions under the cognizance of the PFM. The PFM must be knowledgeable in all these areas and call on experts throughout GSFC and NASA to assist in activities leading to project approval.

As the project progresses, the emphasis in these areas will vary. The early enabling activities (see paragraph 3.1.2.2.1 below) will focus on exploring the trade spaces defined Pre-formulation. During the Definitize Project process (the final step in the Formulation Subprocess) (see paragraph 3.1.2.2.2), the PFM will focus on the generation of products required for project approval. Key elements shall be addressed such as NASA Information Technology (IT) (see reference NPG 7120.5, paragraph 4.1.3), Safety and Mission Success, (see reference NPG 7120.5 paragraph 4.5.1) environmental concerns (see reference NPG 7120.5, paragraph 4.5.5) and Security/Emergency planning, training and response (see reference NPG 7120.5, paragraph 4.5.4).

Projects are generally a subset of larger efforts known as programs. A Project may not be assigned to a Program until late in formulation however, the PFM develops a cooperative and performance-oriented team that supports the Program Integration Manager (PIM) in the Office of the Associated Director and the Program Manager, once assigned. The relationship between the Program Manager, PIM, and the PFM is critical to the success of each. The PFM works in concert with the Program Manager and PIM, but focuses on the day-to-day execution of the project formulation by industrial contractors, universities, NASA personnel, and other government agencies. The PIM/Program Manager must ensure that the products and services from project implementation will meet the program and/or customer needs. It is imperative that the PFM, PIM, and Program Manager be mutually supporting and empower each to do their functions with frequent and open communication.

A good PFM is the key to successful development of GSFC products and services through the formulation and approval of projects. A PFM's ability to draw the best from the participants and manage all aspects of the project is essential. He/she obtains support from senior management. The process discussed in this chapter and in Supplemental Volume 5, Project Manager's Tools, is the foundation for innovation and success for the project formulation team.

3.1.2.2.1 Enabling Activities Enabling Activities, the first step in Formulation, is initiated by STAAC at the end of Pre-formulation with approval of the NBC. Enabling Activities is an evolutionary process for defining a project that will allow implementation within the constraints of the customer and GSFC. The focus should be on refining the options available to accomplish the mission and through a structured process defining those most applicable. During this activity, per NPD 2570.5, frequency spectrum management must be addressed.

The objective is to define an affordable project concept and plan to meet mission objectives or technology goals specified in the Program Plan. The PFM and team will:

- a. Explore the full range of implementation options, including concept, technology availability, and technology needs; (See Figure 3-3a for an overview of types of projects frequently considered at GSFC)
- b. Establish the internal management control functions that will be used throughout the formulation of the project;
- c. Assess the technology requirements and develop the plans for achieving the technology options, including options for partnering and commercialization;
- d. Perform LCC and performance analyses for concepts deemed to have a high degree of technical and operational feasibility, and
- e. Identify estimated project reserves, including reserves associated with risk management.

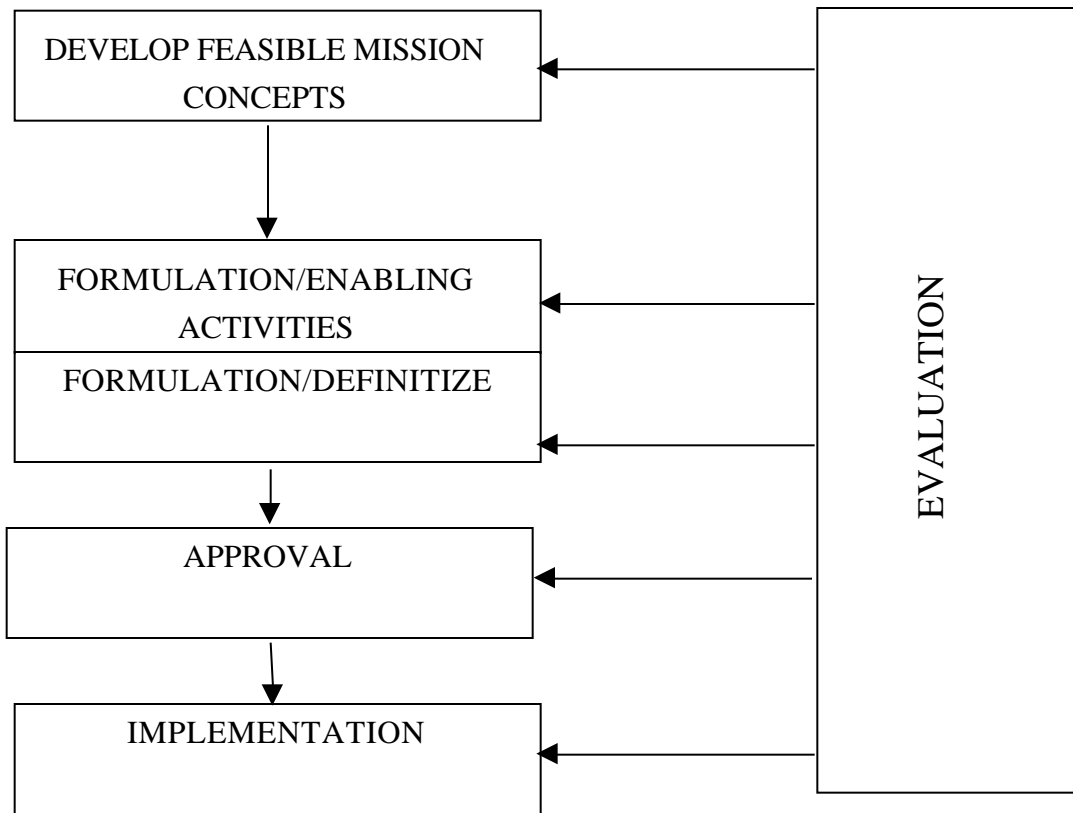


Figure 3-3a: GSFC Program/Project Process Management

Products of the Enabling Activities process, displayed in Figure 3-3b, include a detailed definition of the project concept, and a full understanding of the agreements, approaches, and plans required to meet the technical, budget, schedule, risk management, commercialization, acquisition, and related project requirements and performance objectives. The Enabling Activities process is an iterative activity rather than a discrete set of linear steps. Many times, it is interactive with concurrent execution of the activities until the products have matured and are acceptable to the Program Manager and/or customer. Primary inputs to this process are derived from the Program Plan, which specifies the mechanism to authorize the formulation of projects. The Enabling Activities are planning, systems analysis, technology requirements synthesis, technology and commercialization plans, operations and business opportunities, assess infrastructure, and plan upgrades/development, and lessons learned.

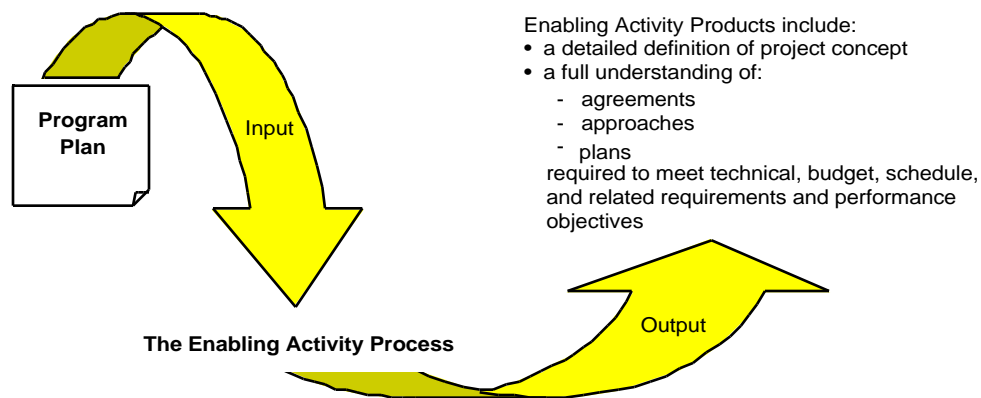


Figure 3-3b. Products of the Enabling Process

3.1.2.2.1.1 Project Planning This activity develops the detailed definition of project requirements and establishes project control to manage the Formulation Subprocess. The PFM shall establish oversight and reporting systems, which integrate the cost, schedule, and technical performance of the project. He/she supports the annual POP cycle by providing assessments of affordability as input to the program's funding requirements. This enables a firm program commitment to accomplish the project and program goals and objectives on schedule and within budget. He/she also supports the annual in-house workforce planning and control process by providing assessments of Civil Service and support service contractor labor necessary to support mission formulation and implementation.

The project control activity provides the PFM with project control and oversight of performance. The project obtains its formal external direction and provides formal internal direction through project planning. To accomplish project planning, the PFM shall perform the activities defined in NPG 7120.5, paragraph 3.1.1.

3.1.2.2.1.2 Systems Analysis In conjunction with the Systems Engineering Division (SED) and AETD, this activity provides the systems analysis and LCC analysis necessary to produce feasible concepts and explore a wide range of implementation options to meet project objectives. The PFM considers technology alternatives, frequency spectrum authorization, operations, business opportunities, schedule, and infrastructure for the project. Risk assessment planning identifies risks and plans risk mitigation. To accomplish systems analysis, the activities defined in NPG 7120.5, paragraphs 3.1.2, shall be accomplished.

3.1.2.2.1.3 Technology Requirements Synthesis This activity examines the project concepts and assesses the technology requirements for feasibility, availability, technology readiness, opportunities for leveraging research, and new technologies. Technology synthesis defines which technologies should be incorporated into the project and which should be considered as crosscutting technology projects to enable future NASA endeavors. The activity involves interfacing with the GSFC Level II NASA Technology and Planning Integration Office (Code 710) and the AETD Chief Technologist (Code 500). Technology is in the following two general categories:

a. **Project-specific Technology:** Those technologies that provide fundamental capabilities without which certain project-specific objectives cannot be met. These technologies generally represent more project-specific needs that are tied to detailed mission objectives. Project-specific technology development activities are managed by the project requiring that technology.

b. **Crosscutting Technology:** Those crosscutting technologies that reduce cost or risk to such a degree that they enable completely new mission options. Those technologies represent multi-mission applications, resulting in aggregate cost savings and/or higher performance. Crosscutting technology must be applicable to two or more enterprises to be funded under the Crosscutting Technology Program. Crosscutting technology projects have Formulation and Approval Subprocesses separate from the projects which will eventually use those technologies, and are executed consistent with the processes described in this document.

Technology requirements synthesis, as defined in NPG 7120.5, paragraph 3.1.3, shall be performed. In addition, technology customers should be identified and involved to ensure that the crosscutting program will satisfy the customer's needs.

3.1.2.2.1.4 Develop Technology and Commercialization Project Plans This activity plans the technology options that satisfy candidate concepts' identified needs. It also develops options for partnering and commercialization. The Technology Commercialization Office (Code 750) should be consulted for assistance with commercialization activities. Further, this activity provides for the development of plans and the establishment of partnerships to transfer technologies, discoveries, and processes with potential for commercialization. Plans may be developed for technologies that are at a sufficient level of readiness to be an integral part of the project. Multi-use technology, which has been identified as important to a mission, can be recommended as a technology project to the Crosscutting Technology Program. Technology and commercialization planning, as defined in NPG 7120.5, paragraph 3.1.4, shall be performed.

3.1.2.2.1.5 Operations and Business Opportunities In this activity, the PFM identifies business opportunities for partnerships in the development and operational elements of the project. (e.g., Launch Vehicles, SOMO, Spacecraft Systems, Instrument Technologies, Science Data Processing, etc.) In searching for partnering opportunities, the PFM will accommodate agreements and partnerships formed at the program level, and remain consistent with the strategic direction issued by the EAA. Partnering opportunities and relationships identified through these activities will be assessed for feasibility through completion of the final agreements. This assessment, as defined in NPG 7120.5, paragraph 3.1.5, shall be performed.

3.1.2.2.1.6 Assess Infrastructure and Plan Upgrades/ Development The PFM assesses the capability, suitability, and availability of the NASA-wide infrastructure to satisfy project requirements. Resources in other government agencies, industry, academia, and international entities will also be considered to minimize program LCC. Plans are developed for any required upgrades and development that may minimize multi-program or multi-project LCC. This assessment, as defined in NPG 7120.5, paragraph 3.1.6, shall be performed.

3.1.2.2.1.7 Lessons Learned This activity consists of collecting and evaluating the Formulation process performance, and determining effectiveness and efficiency with which the process is being executed. Lessons learned shall be developed for improvement of the process. This activity is required by NPG 7120.5A paragraph 3.17 Capture Process Knowledge.

A history of the Enabling Activities and Definitize Project processes shall be maintained which includes significant events, options studied, tradeoffs made, resources expended, time consumed, and any other performance information that may improve the process.

3.1.2.2.2 Definitize Project The Definitize Project activity is the final and most formal step of the GSFC Formulation Subprocess that leads to project approval and subsequent implementation. It is during the Definitization Project process that GSFC organizations prepare to commit to the project cost, schedule, and performance baseline. It is initiated when work starts on the formal

generation of the approval package required for Approval to Implement. Within two years of approval for the project to enter the implementation process a Project Manager is selected jointly.

Definitize Project is the process of converting the preliminary systems design into an optimized, technically-unique design, which becomes the technical baseline for the generation of all resource and support requirements, schedules, and other information in preparation for project approval.

Definitization is performed using both in-house efforts from the supporting GSFC directorates and out-of-house contractors and partners resulting from competitive actions. It is based upon resource availability and policies/constraints/methods affecting resource utilization. It is essential, before implementing a project, to have a full understanding of the scope of work to be performed, which can only be accomplished by complete and penetrating project definition.

This activity covers the full range of technical, management, resource, facility, and procurement assumptions and acquisition strategy and contractor reporting. Also covered are ground rules, plans, procedures, and documentation of an end-to-end verified and customer-validated flight/ground system which meets or addresses, through tailoring, all NASA requirements, including frequency spectrum authorization. There will be a Project Plan developed in preparation for project approval. Mission objectives, requirements, and justification will be fully reviewed. Technical plans will be reviewed, updated, and defined in detail to support the anticipated mission, which should include a proper balance between the hardware and software complexity of the flight and ground segments. Alternate designs will be analyzed to allow selection of an optimum flight and ground systems approach considering technical performance, cost, schedule, and other factors such as technology availability, risks, and the potential for commercialization.

The resulting baseline design will be totally identified, investigated, and documented including all significant interfaces and system/subsystem/component specifications for the flight and ground systems. Full implementation plans, including major make-or-buy decisions, specific-and-detailed WBS, and work packages will be identified with the specific responsible personnel and organizations identified, schedules defined and coordinated, and resources, facilities, and materials specified. In the final stages of the Definitize Project, the Project Plan will be completed and the project will be validated.

3.1.2.2.3 Formulation Products The products to be produced by the Formulation Subprocess are in accordance with NPG 7120.5, Appendix E.4, as shown in Figure 3-4. The formats of these plans are tailorable appropriate to project end-item requirements.

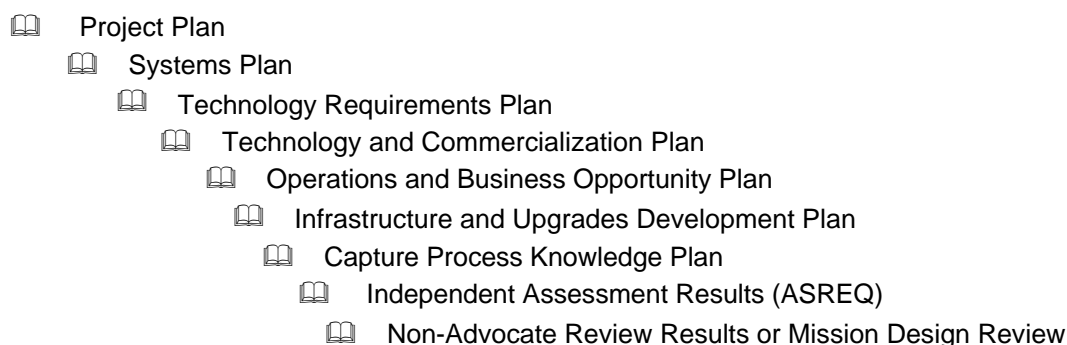


Figure 3-4. Project Formulation Products

3.1.2.3 Project Approval

A project enters the Approval Subprocess to proceed from Formulation to Implementation (see NPG 7120.5, paragraph 3.2.). The Approval Subprocess may also provide approval for a project to continue in Formulation when iterative formulation is required or provide approval for significant change(s) to its Project Plan based upon budgetary or technical considerations. Significant changes in budget or the program, changes in criteria used to approve the project, or changes within the project that violate the original approval criteria necessitate project reformulation and reevaluation for approval. Approval consists of the following:

- a. Successful approval reviews.
- b. A signed commitment letter.
- c. Commitment of full funding (as defined in the POP process) through project completion.
- d. Modification of the Program Plan. (See NPG 7120.5, paragraph 3.2.b, and the Approval Signature Matrix, shown in Table 3-1.)

The set of approval reviews for directed missions typically consists of a NBC review and a NAR (NPG 7120.5, Appendix F) or a MDR/MCR. The NAR is required by NPG 7120.5 for programs and selected projects in order to proceed to Implementation. It is conducted by an independent review team, and coordinated by the IPAO at Langley Research Center (LaRC), paragraph 3.1.2.5.1. The NAR results are reviewed by the NASA PMC, with final approval by the NASA Administrator.

Table 3-1 Approval Signature Matrix
(Denotes Required Signatures Only)

Documents	Administrator	Enterprise Associate Administrator	Lead Center Director	Center Director	Program Manager	Project Manager
Formulation Authorization		✓				
Program Commitment Agreement	✓	✓				
Program Plan		✓	✓		✓	
Project Plan		(Requires Program Plan Mod: NPG 7120.5, par. 3.2b)		✓	✓	✓

Projects not selected for a NAR must have an MDR/MCR. An MDR provides the same information for review as a NAR, but the results are reviewed by the GPMC at the MCR, with approval by the appropriate EAA.

In requesting approval for proceeding to implementation, the Project Manager must obtain a commitment of GSFC resources from the NBC if the project meets or exceeds the thresholds established for NBC review (reference: GSFC Director's New Business letter dated 4/14/98). Information presented to the NBC consists of:

- a. Description of the opportunity
- b. Roles and responsibilities of the partner and GSFC for implementation
- c. Schedule
- d. Science impact
- e. Technology content
- f. Customer advocacy

- g. Workforce and budget needs
- h. Why GSFC should be involved, addressing the Strategic Plan

The Directed Mission (Project) enters Implementation after the commitments are signed and a successful NAR or MCR is achieved.

3.1.2.4 Project Implementation

NASA's Implementation Subprocess, as described in NPG 7120.5, paragraph 3.3, Project Implementation, encompasses the Design, Development, and Sustainment of a project, or the former Project Planning Phases C, D, and E (Design, Development, Operations: see Volume 1, Table 1-1). A project enters the Implementation Subprocess upon successful completion of the Approval Subprocess. Implementation is outlined in Figure 3-6.

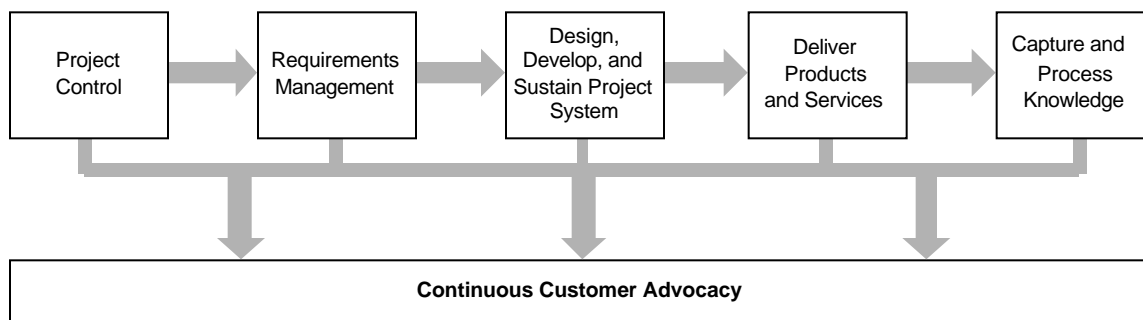


Figure 3-6. The Project Management Implementation Subprocess

GSFC projects range in complexity from balloon flights and sounding rocket missions to instrument, ground station, operations center, and small and large spacecraft builds. GSFC's Implementation Subprocess, therefore, varies from project to project. There are, however, several key concepts common to most projects' Implementation Subprocesses as described below.

3.1.2.4.1 Project Control This activity, as required by NPG 7120.5, paragraph 3.3.1 unless otherwise noted, involves the Project Manager's responsibility to exercise control and overall direction of the project budget, schedule, and procurement. Every GSFC project shall have baseline agreements and documentation such as contracts, Task Plans, Customer Agreements, and/or Memorandums of Agreement (MOA), which fully describe the work authorized (See NPG 7120.5, paragraphs 1.4, 3.3.3, 3.3.4, 4.3) including scope, schedule, and budget. These documents are the basis upon which all work on the project is performed and evaluated. When applicable, the Project Manager shall work closely with the Contracting Officer (CO) and the Contracting Officer's Technical Representative (COTR) to ensure that documents are sufficient to fully encompass the work to be performed on the project and that the contractor is in compliance with its terms and conditions throughout the Implementation Subprocess. A single project may have multiple contractual documents and/or agreements.

The Project Manager shall also work closely with the customer identified in the Formulation Subprocess to be sure that the contractual documents meet the customer's needs. Once the contractual documents are approved by the appropriate authority, the Project Manager shall manage and execute all procurement activities and agreements (including intra-agency and external). The FAR or the NASA FAR Supplement generally determines approval authority.

One of the Project Manager's fundamental tools for tracking the project is the Work Breakdown Structure (WBS). The WBS is developed before the Implementation Subprocess and is of sufficient detail to allow insight into every significant project design and development activity and subsequent

reporting. Every GSFC project shall use a WBS of some form, which includes a description of work to be performed under each WBS element. The extent of detail necessary in a WBS is left to the judgment of the Project Manager. The WBS is included as a portion of the Project Plan. Once a WBS is developed along with its WBS dictionary, individuals responsible for each element should be identified, along with a basic milestone schedule of accomplishment. Critical project milestones should be part of the contractual documents. The milestone schedule should then be used to develop need dates for work to be performed and a scheduling system used to track work performed versus need dates. The system and its complexity are choices left to the discretion of the Project Manager.

Once the WBS and schedule milestones and relationships are established, cost estimates can be made for labor, materials, and associated cost elements for each activity and then added to the plan as a resource requirement. There are many tools which can be utilized for this integration of work, schedule, and cost. The most critical aspects of this process are: (1) identify individuals for each activity, (2) fix responsibility for meeting technical performance, schedule, and cost commitments, and (3) employ an ongoing method for monitoring detailed and aggregate performance versus plans to meet that commitment. Planning for a contractor or in-house effort should map to the POP budget planning and be tracked on that basis. The Project Manager and supporting Resources Managers determine which system is most appropriate, given the magnitude of the effort, contract type, program risk, and other factors.

The most sophisticated tools for the integration of project control information fall under the area of Earned Value Management (EVM), which has evolved from the old NASA Performance Analysis Report and the newer Performance Measurement System. EVM now represents an adopted NASA/DoD/Industry standard. EVM includes many tools for planning, monitoring, and forecasting. Further guidance can be obtained from NPD 9501.3, NPG 9501.4, and NPG 7120.5. There are also standard contract clauses for use with out-of-house efforts in process at this time. The first major Project activity for EVM is an Integrated Baseline Review conducted by the project with EVM Focal Point assistance. EVM does not impose a particular system, but provides guidelines for what any planning, tracking, and forecasting system being utilized should contain. Many off-the-shelf packages can be tailored for this purpose.

The combination of cost, schedule, and work performed are critical in allowing the Project Manager to assess progress during design and development, and they provide the detail necessary to determine when corrective action is necessary. The Project Manager continually assesses the status of project reserves and executes project risk management plans described in the Project Plan to determine when reserves should be used. The Project Manager shall also develop and track performance metrics to assist in this determination. See NPG 7120.5, paragraph 4.3. These metrics must include cost, schedule and work performed metrics. All other reporting requirements including content, format, and frequency shall be defined in the Project Plan and the contractual document.

The Project Plan shall be updated as required (See NPG 7120.5, Paragraphs 3.1, 3.2 and 3.4), to maintain compatibility between the plan and the resources available. Full participation by the Project Manager in budget planning approval and execution process is required. Changes in budget, the program, and criteria used to approve the project, or significant changes within the project that violate the original approval criteria, would necessitate project reformulation and reevaluation for rebaseline or termination. The approval may be simplified by focusing on the element that caused reevaluation.

The Project Manager should maintain the project within the scope defined in the contractual document(s) and, in any event, lead and direct the project to meet its commitments in the Project Plan and the PCA. Project scope includes cost, schedule, technical performance, and work to be performed. Contracts are to be administered in conformance to NASA/GSFC procedures for financial management reporting, contingency and APA, and LCC's. Any proposed changes to project scope require a project to re-enter the Approval Subprocess. This subprocess is described in Volume 1, paragraph 1.4.2.

The Project Manager has several other responsibilities in controlling the project. Throughout all design, development, delivery, and operations activities, the Project Manager shall ensure establishment and maintenance of an effective safety and mission success activity. The Project Manager shall ensure that all required enabling technology and NASA IT resources are provided as planned (see reference NPG 7120.5, paragraph 4.1.3). The Project Manager shall assess and document the performance of the entire Implementation Subprocess, and respond to customer and Evaluation Subprocess assessments and recommendations.

3.1.2.4.2 Customer Advocacy The Project Manager is to proactively consult and involve the customer throughout the Implementation Subprocess to ensure customer satisfaction with the delivery of safe, quality products and services within performance, budget, schedule, and other program and project commitments. (See NPG 7120.5, paragraph 3.3.2.)

3.1.2.4.3 Requirements Management The Project Manager shall ensure that requirements developed during the Formulation Subprocess are properly divided and incorporated into detailed implementation documentation sufficient for successful project design, development, and operations. In order to track this documentation, each project shall have a Configuration Management System (CMS). The choice of a CMS is left to the discretion of the Project Manager. All project requirements and performance specifications shall be under configuration control. The CMS shall also maintain traceability to all program requirements. The Project Manager shall review and finalize all agreements, update technology requirements and commercial agreements, as well as prepare resource requirements to implement the total set of project requirements including LCC's. (See NPG 7120.5, paragraph 3.3.3. and GPG 8700.2.)

3.1.2.4.4 Design, Develop, and Sustain Technology development and project design, development, and sustaining activities shall be accomplished in accordance with the validated processes described in GPG 8700.1, 8700.2, 8700.3, 8700.4, to ensure quality products and services. The Project Manager manages the design and development of the project system, including hardware design and manufacture, software development, and all testing and verification activities (i.e., component, subsystem, and system level) needed to demonstrate the appropriate level of confidence and risk mitigation in the design. Where necessary and consistent with the baseline project, technology research and development shall be performed in order to meet requirements, as specified by the requirement management activity described in paragraph 3.1.2.4.3. (See NPG 7120.5, paragraph 3.3.4.) This Implementation activity also notes sustaining activities, including operations, engineering, logistics, and establishing and/or upgrading the supporting infrastructure as required.

To accomplish the Design, Develop, and Sustain activity, the Project Manager shall have an orderly system of insight/oversight, review, evaluation, documentation, and reporting. See NPG 7120.5, Section 3.3.4.2. These functions include the following:

- a. Conduct architectural, functional, system, and subsystem design reviews as specified by the Project Plan.
- b. Execute acquisition plans and contracts with surveillance insight/oversight of contractor(s) and/or supporting staff.
- c. Maintain traceability of requirements to system designs and specifications.

- d. Ensure the accomplishment of system verification and acceptance testing.
- e. Provide performance metrics, visibility, and status per Project Plan and project direction, including any project variance with cause, impact, and corrective action.
- f. * Design, develop, test, and verify technology materials and information for delivery to the Agency, the scientific community, and commercial customers or partners per agreements in NASA's technology plans.
- g. * Conduct technology infusion and/or transfer in accordance with project technology and/or commercialization plans, including incorporating new technology and commercialization as available and where appropriate per approved plans. Technology commercialization plans should be updated annually.
- h. Provide for discipline and system engineering for the design, implementation, and sustain technology, and its commercial, upgrades to existing infrastructures that deliver cross-project/program operations products and services to the project.
- i. Provide sustaining engineering for efficiency enhancements and for safety and obsolescence plan development and execution.
- j. Use technical standards and guidelines with preference to voluntary consensus standards where practical.
- k. Use the International System of Units (Metric System) measurement system, where practical.
- l. Ensure the generation, identification, control, distribution, and reporting of all engineering and technical management information generated during project formulation and implementation.
- m. Ensure that design and sustaining activities provide cost-effective logistics support, including operational delivery of services and products to the customers.
- n. Ensure that hardware system verification includes the use of practical and cost-effective software, and is in compliance with NASA independent verification and validation requirements.
- o. * Document the design and development of any new technology developed as part of the project to ensure legal protection of new intellectual property.

* These support NASA's high priority to develop and transfer new technologies.

3.1.2.4.5 Deliver Products and Services The culmination of the project is the delivery of the programs, products, services, and technology to the customer. See NPG 7120.5, paragraph 3.3.5. These include: (1) deliverable hardware, software, infrastructure, documentation, and training, (2) operations of delivered systems, (3) production of intellectual products for science and technology customers, and (4) process knowledge.

For both mission and technology projects, the purpose of this activity is the delivery of committed Project Plan products and services to all customers. Specific products and services in each of the four categories above are as follows:

- a. Deliverable Hardware, Software, Infrastructure, Documentation, and Training:
 - Project flight and ground systems, including spares, logistics, and ground support equipment.
 - Scientific breakthrough and new technology through data, information, products, and services per agreements in the project technology plans.
 - Space operations infrastructure upgrades for cross-program/customers.
 - Agency labs and technology infrastructure upgrades.
 - System maintenance and operating procedures and training.
 - As-built documentation.
- b. Operations of Delivered Systems, and Production of Intellectual Products for Science and Technology Customers:
 - Perform operational readiness tests for project end-to-end system readiness and support integrated program testing to execute the Operations Plan and to deliver customer products and services.

- Launch, operate, and maintain project flight and ground elements to deliver customer products and services per the approved Operations Plan.
 - Provide customer support services, including the delivery of materials and information to commercial customers. Develop and deliver user guides, training, and simulation support for customers.
 - Maintain configuration management of mission and operations plans, including upgrades.
 - Collect, analyze, and report operations performance metrics including Technology and Commercialization Plan performance data and status.
 - Develop maintenance and operations requirements for new systems/upgrades and support sustaining engineering activities.
- c. Process Knowledge:
- Report contractor performance assessments to contractor and record for future source selection (see NPG 7120.5, paragraph 4.4.4.2).
 - Develop technology capability forecasts, and identify synergistic commercialization opportunities.
 - Develop information and materials for the use of non-aerospace and commercial customers, such as outreach materials.
 - Record project history and lessons learned/send to the NASA Chief Engineer.

d. Mission Termination:

Operating space systems are terminated in accordance with NASA Management Instruction (NMI) 8640.2B.

3.1.2.4.6 Capture Process Knowledge The Capture Process Knowledge Activity supports continuous improvement of the Implementation Subprocess through assessment of process performance metrics. See NPG 7120.5, paragraph 3.3.6. In support of this activity, the Project Manager shall be responsible for the following:

- a. Collection and analysis of project process metrics and the identification of areas of exceptional or substandard performance.
- b. Performance of root-cause analyses in identified problem areas.
- c. Development of recommendations for correcting deficiencies and/or adopting better processes.

The Project Managers shall establish an ongoing mechanism to collect and evaluate process performance and identify lessons learned during all activities of Project Implementation (GPG 8730.3). Lessons learned should be considered by Project Managers for their own projects. Lessons learned with broad application or utility to other Project Managers will be submitted to the NASA-wide Lessons Learned Information System (LLIS). Lessons learned identification should be a formal product of major reviews (e.g., NAR, Confirmation Review (CR), Preliminary Design Review (PDR), Critical Design Review (CDR), Mission Operations Review (MOR), Mission Readiness Review (MRR), Flight Readiness Review (FRR), and Independent Annual Reviews (IAR)) and submitted to the LLIS as deemed appropriate by the Review Board. The URL for the LLIS can be found in Appendix D.

3.1.2.5 Project Evaluation

The Evaluation Subprocess provides an independent assessment of the continuing ability of the project to meet its technical and programmatic commitments using the experiences and perspectives of customers and other experts independent of the project (See NPG 7120.5, paragraph 3.4). The Evaluation Subprocess is applied throughout the life cycle of projects and consists of the planning and conducting of reviews and assessments during the Formulation and Implementation of a project.

Evaluation during Formulation ensures that programs and their projects support NASA's goals and strategic plans and that the project can be successfully conducted within allocated resources and applicable constraints. Evaluation supports the Approval Subprocess by developing recommendations from supporting reviews, evaluations, and tests, as described in GPG 8700.4, before proceeding with succeeding project life cycles or terminating the project. Evaluation during Implementation ensures that projects are being successfully executed according to plans, and provides recommendations for enhancing the technical and programmatic performance of projects.

At GSFC, there are typically two types of reviews: those held by groups external to GSFC, and those held by the project in conjunction with the SRO (Code 301). Reviews are chaired and staffed by personnel independent of the project. The GPMC chair reviews proposed assessment team membership to ensure that review and assessment teams incorporate knowledgeable experts, both internal and external, including customer representatives. External reviews recommended for consideration are described in NPG 7120.5, paragraph 3.4.1 and Appendix F. These are the IA, the IAR, EIRR and a NAR. Each of these reviews is held at the discretion of the PMC, except the EIRR which is held at the discretion of the EAA. All other project reviews are tailorable and are held at the discretion of the Project Manager, GSFC senior management, or NASA Headquarters. The timing, content, frequency and potential combination of reviews may be tailored to meet the needs of the individual project.

The conduct of each assessment and review shall be coordinated with the Project Manager to minimize project disruption. Where practicable, reviews should be combined in order to reduce total numbers and costs.

Projects that report to the NASA PMC may be required to have an independent review. Independent reviews may be held at the program level and will, to some extent, involve the assessment of the program's projects. Independent reviews for projects which report to other PMC's are held at the discretion of either the GSFC PMC or the other appropriate PMC.

For projects with exceptional risk, higher cost, or high visibility, the EAA may establish an EIRR to validate the project's performance against the program-level requirements and objectives set forth in the Program Plan for the project. The EIRR results will be reported to the EAA, who will report the results to the GPMC.

Requests for additional review and assessment of projects may arise outside the normal process. Requests may come from Congress, NASA's Inspector General, the General Accounting Office (GAO), advisory groups such as the Space Science Advisory Committee, and other similar sources. NASA's Chief Engineer will coordinate responses to external review requests, work in concert with the EAA (the office responsible for management controls) and GSFC to disposition such requests, and coordinate scheduling of additional reviews and assessments, when required.

3.1.2.5.1 Independent Reviews Details of the Evaluation reviews are given in Supplemental Volume 5, Project Manager's Tools, Section 5.4, and Appendix F of the NPG 7120.5. Concurrent with the Formulation Subprocess, Evaluation must include a MDR/MCR, which include an LCC and Independent Cost Estimate (ICE). The MDR/MCR determine the readiness of the project, either to proceed with further Formulation or to request approval to enter Implementation.

If a project is also designed as a program, then the MDR/MCR is replaced by a NAR. An Independent Review Team, as specified in the Project Plan, then coordinates the NAR of a program. The review is conducted by the IPAO for projects reviewed by the NASA PMC.

In addition, at the request of either the GSFC Director or the Program Manager, the Project Manager will support an IA of a project. The IA's are conducted by the IPAO. They consist of both technical and LCC assessments of advanced concepts, and are typically conducted during project formulation.

The IAR is the means by which the NASA PMC ensures its awareness of the status and performance of the programs and projects for which it is responsible. These reviews are held during the Implementation Subprocess, and are used to validate project conformance to the PCA.

3.1.2.5.2 Other Reviews Concurrent with the Implementation Subprocess, evaluation consists of reviews that measure project performance and compares that performance with Program and Project Plans. At a minimum, reviews assess technical achievements, adherence to schedules, projected costs, issues, concerns, plans for addressing previously unanticipated occurrences, and other project metrics. The content, number, and schedule of reviews can all be tailored according to the project needs.

Consistent with GPG 8700.4, the Chief of the GSFC SRO, together with the Project Manager, identifies the schedule and subject of system reviews in a System Review Plan (SRP). The performing directorate, the Office of Systems Safety and Mission Assurance, and the Center Director provide approval of the SRP. The SRO appoints the chairperson for the review team. The chairperson will, in turn, select independent technical experts to serve as review team members. Details concerning the SRP, review teams, and approvals can be found in GPG 8700.4.

Special purpose reviews (e.g., a Termination Review) shall be conducted at the discretion of the GPMC. Requests for special purpose reviews may come to the GPMC from customers or line organizations. In requesting a Termination Review, the GPMC will consider the anticipated inability of a project to meet the commitments contained in its controlling agreements and plans. Examples include a projected cost at completion that exceeds the costs allowed by the Project Plan, an unanticipated change in GSFC strategic planning, or an unanticipated change in NASA's budget.

The objective of the Plan and Conduct Reviews and Assessment activity is to assess the value to projects of the Evaluation Subprocess and to determine the effectiveness and efficiency with which the subprocess is executed. Lessons learned shall be developed for improvement of the PAPAC Process.

3.1.3 ISO 9001

All projects shall implement a Quality System, beginning with the Formulation Subprocess, in accordance with requirements found in GPG 8730.3, the GSFC Quality Manual.

3.1.3.1 Quality Management System (QMS) Council

The Center Director appoints a QMS Council (QMSC) consisting of representatives nominated by directorates and offices of the Executive Council. The directorate representatives interface with their respective directorate staffs, Laboratory or Division Chiefs, Project Managers and their staffs to carry out the duties in GPG 1060.1, Management Responsibility, paragraph 2.3.

3.1.3.2 ISO 9001 Implementation

Project/Product Managers shall be responsible for ensuring that his/her project (product) conforms to all applicable elements of QMS. He/she will ensure that the necessary procedures are in place, and that they are properly adhered to. See GPG 8730.3, the GSFC Quality Manual.

3.1.3.3 Internal Audits

Project/Product Managers shall support annual internal audits as described in GPG 9980.1, Internal Audit System, to verify the effectiveness of the Quality Management System.

3.2 Guidance for the New Project Formulation Manager and Project Manager

3.2.1 GSFC Program/Project Responsibilities

The Enterprise, consistent with the Enterprise Strategic Plan and the budget, authorizes programs. The Enterprise authorizes the formulation of a program by a designated Lead Center or Field Center. The PCA documents the agreement between the Enterprise and the NASA Administrator for the implementation of the program. Subsequently, the Program Plan documents the agreement between the Enterprise and the Field Center program office. These documents are presented for signature at the time of program approval.

The Enterprise identifies the Program Executive and the Program Scientist (Volume 2, Paragraph 2.4) to interface with the Program/Project Managers and Project Scientists during the formulation and implementation of a program.

Project Formulation is conducted for the program in accordance with the Program Plan and as directed by the Enterprise. The Project Plan is prepared during Formulation and signed at Approval for Implementation. The Enterprise will issue an AO for PI mission projects such as Explorers, STP, Discovery, and ESSP. The Enterprise will issue an AO for investigations in support of Enterprise-directed projects such as Upper Atmosphere Research Satellite (UARS), HST, Cosmic Background Explorer (COBE), etc.

The GSFC Project Manager is the senior NASA line official solely concerned with the execution of a particular project. GSFC invests full responsibility for mission success in the Project Manager, with scientific guidance and support provided by the Project Scientist. Within the confines of established policies and procedures, full authority and accountability are included with this management responsibility. Therefore, he/she is responsible for the effective total management of the project in accordance with the Project Plan and other applicable directives. A fundamental principle is that the Program Manager and the Project Manager each function in his/her own sphere of management influence, and each depends on the cooperation and effectiveness of the other.

The most desirable Program/Project Manager relationship evolves when those individuals develop a cooperative team effort to ensure the completion of the project within cost, schedule, and technical performance requirements. The Project Scientist plays an important role in advising the Project Manager on all matters involving science and experiments/instruments and ensuring achievement of approved scientific objectives. The following paragraphs describe the major roles and responsibilities of the Program Manager, Program Scientist, Project Manager, Project Scientist and Product Design Lead (PDL).

3.2.1.1 Roles and Responsibilities of The Program Managers

The Program Manager is responsible for the following:

- a. Program planning, including recommendation of program objectives, requirements, implementation guidelines, budget and milestones, and preparation of Program Plans and supporting development of PCA's.
- b. Developing, recommending, and advocating program resources.
- c. Allocating budget to projects.
- d. Establishing support agreements.
- e. Executing and overseeing the Program Plan.
- f. Controlling program changes.
- g. Approving Project Plans and associated changes.
- h. Establishing project performance metrics.

- i. Integrating the planning and executing of individual projects or programs composed of multiple interdependent projects.
- j. Reviewing and reporting program/project performance.
- k. Complying with applicable Federal law, regulations, executive orders, and NASA directives.

In pursuit of these responsibilities, the Program Manager is required to develop and maintain a close relationship with the Project Manager(s) and other GSFC officials on the program utilizing sound technical and managerial judgement.

3.2.1.2 Roles and Responsibilities of The Program Scientist

The Program Scientist is responsible to the Program Office for achievement of scientific goals and objectives of the program, for dealing with the scientific community, and interfacing with the Project Scientist(s). The Program Scientist participates in the development of the AO and obtains the necessary coordination and approval for the AO. He/she recommends appointments to the Ad Hoc Advisory Subcommittee of the Steering Committee and is responsible for preparation of necessary documentation. The Program Scientist forms a team with the Project Scientist(s) and the program/project Science Working Group Teams to formulate plans for program/project advocacy and to inform the public of the importance of the program/project. The Program Scientist and Project Scientist(s) work together to ensure that science objectives of the program/project are met.

3.2.1.3 Roles and Responsibilities of The Project Formulation Manager/Project Manager

The Project Formulation Manager/Project Manager is responsible for the following:

- a. Management and dedication of the concept study/project team.
- b. Preparing and maintaining the Project Plan, specifications, schedules, and budgets.
- c. Establishing support agreements.
- d. Acquiring and using participating contractors.
- e. Executing the Project Plan in Implementation.
- f. Supporting program management and integration.
- g. Reporting project performance and status, including contracts.
- h. Compliance with applicable Federal law, regulations, Executive orders, and NASA/GSFC directives, including the GSFC QMS.

Director of STAAC (if a PFM) or the Director of FPPD (if a Project Manager) will carry out these responsibilities within the delegated authority and in the accordance with the QMS. He/she directs and coordinates all supporting elements with other centers, NASA Headquarters, and other agencies of the U.S. government or foreign investigators, as well as all necessary contractual efforts. The PFM/Project Manager keeps GSFC and Headquarters management informed concerning the status of the study/project while developing a close working relationship with the Program Manager. He/she takes whatever additional actions are required to ensure the successful completion of the study/project, including delivery of validated end-item data and services to users (customers).

3.2.1.3.1 Project Manager Selection This is a critical function carried out by the Director of FPPD with the support of the Director of STAAC, after a consultation with the customer, and concurrence from the GSFC Center Director. This selection must be in accordance with GPG 8730.3, paragraph 2.2.1, GSFC Quality Manual. The candidate Project Manager will usually have a technical background, project experience, and training in the use of project management tools. Since he/she will interface extensively with the other Directors, the Directors of are often consulted during this selection process.

3.2.1.3.2 Project Management Transition The smooth transition of leadership is a critical element of project development. The intent is that the development of the Advanced Mission Concept (AMC), Project Formulation, and Project Implementation appear as a seamless environment to the customer and the stakeholders even though there are changes in leadership. There are programmatic, administrative, and technical personnel and resources required to take the initial suggested science concept through completion of the science mission. Normally key administrative and technical personnel should remain associated with the project from evolution of the concept through completion of the science mission when practicable.

Program/Project personnel represent the primary leadership throughout the life cycle of a project and are the key points of contact for the customer. During the development of the AMC, a Lead Scientist and a PFM are assigned. They are expected to complete the AMC, gain NBC approval to proceed to Formulation, complete the Enabling Activities, start generation of the approval package for Implementation, and definitize the project. The Lead Scientist, PI and the Project Manager are expected to implement the project as defined within the allocated resources, maintain an active customer interface, manage any changes required, and develop the transition of the mission to an operational organization.

The transition of the project from the PFM position to the Project Manager position needs to be smooth to minimize the impact to the process and the relationships with customers or stakeholders. The transfer of formulation ownership from the PFM to the Project Manager is critical to the success of the process and mission implementation. The Project Manager will be appointed before the Definitization activity of the Formulation Subprocess begins. The specific assignment of personnel to these positions will be addressed as the project evolves through Formulation to Implementation. There are many options available to STAAC and FPPD for assignments throughout the process. Generally assignments proceed as follows, in accordance with GPG 7120.2:

- a. Assignment of a PFM for Formulation from existing STAAC personnel.
- b. Matrix of FPPD employee to STAAC for assignment as a PFM. FPPD employee will be rebadged to STAAC if this assignment occurs more than one year prior to the start of the Definitization activity.
- c. Rebadging of the assigned STAAC PFM to FPPD to continue as the Project Manager or other project management position such as Deputy Project Manager, Observatory Manager (OM), or Instrument Systems Manager (ISM) or Operations Manager.
- d. Assignment of a Project Manager from FPPD and reassignment of the (STAAC) PFM to another STAAC position.

None of the options will be considered as standard, since each situation will need to be decided based on several factors including the scope and complexity of the project, experience and capability of individuals, and inputs of customers and stakeholders. The options concern Enterprise-Directed Projects, but options c. through d. should also be considered for Competed Projects.

Appointments of PFM's and Project Managers are complex considerations which follow these ground rules:

- a. The Director of STAAC with the Director of FPPD jointly appoints a PFM for flight project studies after receiving recommendations from the Chief, Project Formulation Office and the Program Manager.
- b. With the concurrence of Headquarters and the Goddard Center Director, the Director of FPPD, supported by the STAAC Director, appoints a Project Manager no later than the beginning of the Definitization activity of Formulation to lead the effort through the remainder of the Formulation Subprocess and the Implementation Subprocess.

3.2.1.4 Roles and Responsibilities of Project Scientist

The Project Scientist is responsible for ensuring the satisfactory accomplishment of the scientific objectives of the mission. He/she reviews the Implementation of the project to ensure that the total system is consistent with the overall project scientific objectives and the validation of science products takes place with customer involvement. He/she, as a senior member of the project team, advises on other project activities. He/she provides leadership in ensuring that the scientific data are effectively used, and that scientific results of the mission are expeditiously produced. The Project Scientist evaluates all scientific requirements placed on the Project Manager and others involved in the program.

The Project Scientist manages scientific aspects of the project, acts as the scientific advisor to the Project Manager, is the scientific spokesperson for the project and for the investigators, and chairs the Project Science Working Group (PSWG) or team. The Project Scientist represents the PI or the Team Leader in their relationships with the Project Manager, maintains the science integrity of the mission within the agreed-upon time and funding constraints, and maintains cognizance of individual as well as overall science investigations included in the project. He/she reviews and makes recommendations to the Program Scientist for the approval or disapproval of proposed modifications to investigate science objectives or instrument change proposals, and assists in resolving conflicting requirements between scientific instruments and the spacecraft and between different instruments. The Project Scientist reviews the science budget and all other resources including spacecraft power, weight, etc., and advises the Project Manager on their disposition. He/she reviews data analysis plans and programs in order to ensure timely and adequate analysis of spacecraft data and is responsible for validation of the final data set. The Project Scientist assists and cooperates with the Program Scientist in carrying out his/her roles and responsibilities. He/she ensures public dissemination of scientific results through professional groups, and the Office of Public Affairs, and ensures the archiving of scientific data.

The Project Scientist further ensures that feedback is provided to NASA Headquarters and GSFC management regarding his/her assessment of mission success. Mission objectives to be used in making the assessment are set forth in the Project Plan.

3.2.1.5 Roles and Responsibilities of Product Design Lead (PDL)

The PDL is responsible for establishing goals and objectives, as well as establishing the basic approach for meeting goals and achieving objectives. As leader of the Product Design Team (PDT), the PDL is responsible for defining the team organization and responsibilities, assigning duties and responsibilities to qualified personnel, developing a schedule and budget, determining logistics support requirements, and establishing communications among organizations supporting the product design effort. In order to ensure the integrity of the design effort, the PDL is responsible for establishing a method for defining and documenting each technical interface; documenting and maintaining design plan information; and developing a validation plan per GPG 8700.3, which addresses environmental tests, functional tests, plans for final analysis and reviews which address customer participation in all aspects of validation, product release, and maintenance of validation records. Finally, the PDL is responsible for ongoing evaluation of the design, and updating of the validation plan as necessary.

3.2.2 GSFC Principles of Project Management

While technical expertise and sound management practices are major keys to success for Project Managers and projects, there are other elements such as dedication, hard work, self-discipline, perseverance, and patience which are of equal importance in the overall scheme. However, the most important characteristic of a successful Project Manager is a firm, positive attitude towards the immediate/future work. This is exemplified by a “CAN DO,” attitude while focusing on ways to overcome difficulties in accomplishing the technical work on time and within costs. In other words, the successful Project Manager plans his/her work and works his/her plan with confidence. The best-planned project will, however, have certain elements of risk. The “CAN DO,” Project Manager is aware of these risks, and will strive to offset them by parallel technical and management paths, adjusting activities to offset risks such as by modifying the project schedule or adding funding contingency.

Another major ingredient for successful project management is teamwork. The Project Manager provides the leadership in formulating an effective team. Additionally, he/she must provide leadership at all levels and aspects of the project. In a true team effort, all project personnel must work together in the process, striving for excellence in the delivery of the end product or service. The successful Project Manager instills in his/her team a commitment to meet technical requirements, as well as cost and schedule, and the need for constant and clear communication with all participants. While each team member strives for excellence in his/her own area of work, he/she additionally supports (with a critical inquisitive mind) all other members of the team by asking appropriate questions and volunteering information or advice. This continual critique of one's own work and that of other team members (always looking for a flaw in the assumptions, concepts, or design) often uncovers areas of concern or potential problems that another team member may fail to recognize because he/she may be “too close to the trees to see the forest.” The Project Manager should promote and encourage a team environment in the project, realizing that goals and objectives which may seem difficult or insurmountable to an individual are quite often achievable by the team.

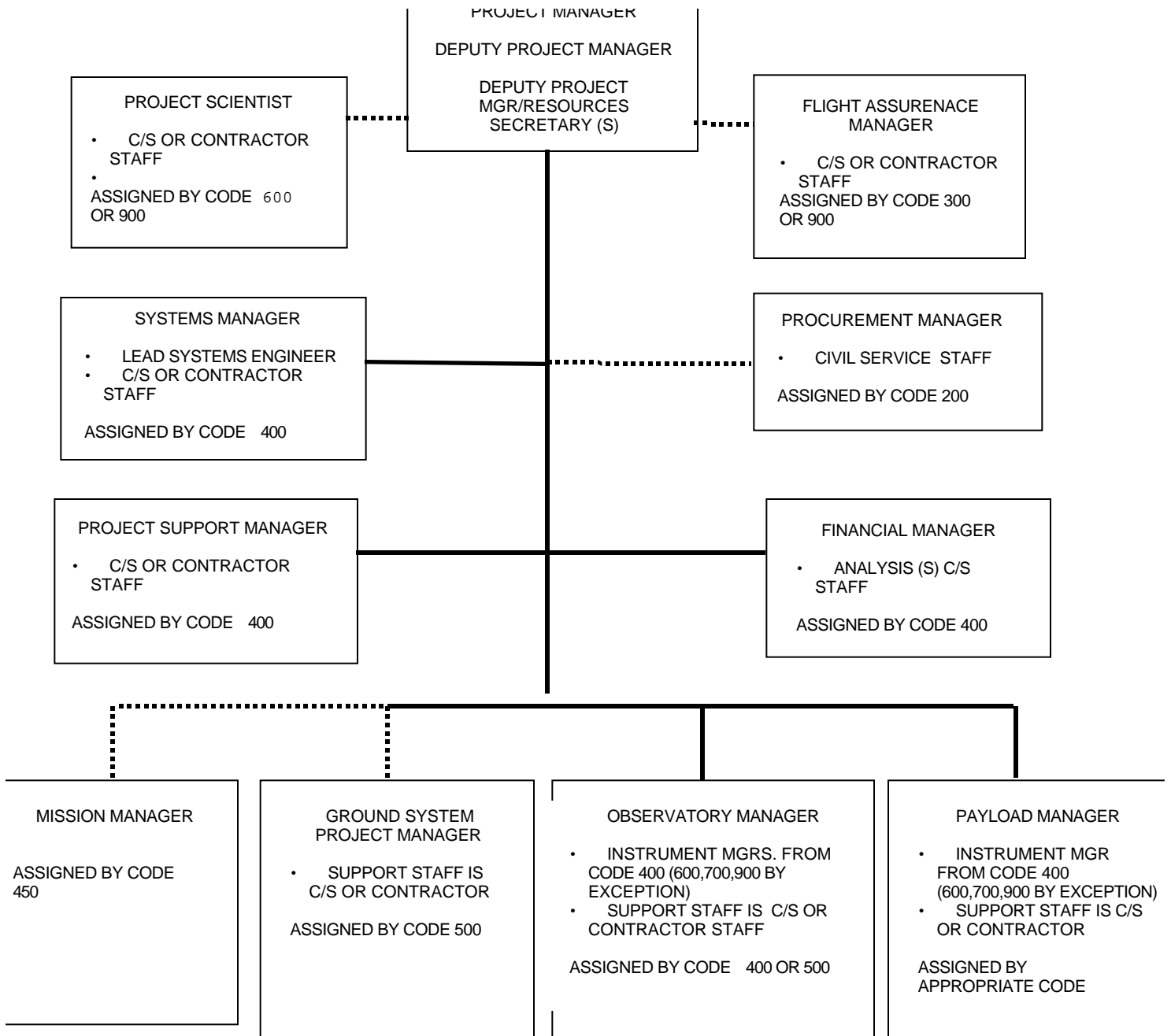
The following are key considerations in managing a Project:

- a. The foremost principle of project management is the identification and integration of project requirements and constraints into a complete set of project requirements, which can be implemented within an agreed budget and schedule.
- b. The Project Team must have a clear understanding of the roles and responsibilities of each project group or contributing functional group. In addition, those with responsibility for ensuring performance must understand their limitations and respond accordingly to those who have other management responsibilities.
- c. The functions of project management, systems management, systems engineering, integration, and project control must be well understood. The Project Manager must make the best possible use of the skills of his/her personnel.
- d. The Project Manager must manage the outward interfaces without stifling communications, while providing effective leadership within the project.
- e. The benefits and limitations of a matrix management system must be understood.
- f. The Project Manager must establish an organization a climate that fosters cooperation and goal achievement.
- g. The NASA management values of planning and control, promoting achievement, understanding and supporting others, and managing interpersonal relations must be understood to promote the project group interactions that have been so successful in the past.

3.2.3 GSFC Project Organization and Support

3.2.3.1 Sample Project Organizations

Figure 3-7 illustrates a sample program/project organizational structure. It should be viewed as a starting point when forming the project organization. However, the individual project organizational structure should be tailored to meet and reflect unique project goals and needs, and thus may vary from the "sample" structure. In general, the majority of GSFC flight projects will be located organizationally within the FPPD (Code 400). Flight projects are organized to be compatible with the work to be performed, and variations do occur. The Systems Assurance Manager (SAM) and Procurement Manager are normally collocated with the project. The Project Scientist may or may not be collocated with the project. The top-level project organization is composed of a group of senior managers selected for their capabilities in their areas of expertise. They form the nucleus of the project organization and are collocated so that they function as a close-knit team for optimum project control and management. Those engineering and support positions below the systems manager level normally are only collocated if their support to the project is full time or nearly full time. If they support more than one project they are normally located at their home directorate. On an exception basis, some of these positions may be deemed to be critical enough to warrant collocation or even reassignment to FPPD (Code 400).



..... NON-CODE 400 OR PART TIME
 ——— CODE 400/NORMALLY FULL-TIME

Figure 3-7a Classic Project Organization Chart

3.2.3.2 Typical Key Project Personnel

Figure 3-7a and 3-7b shows the organization structure of a sample project and also shows the organization structure of a sample PI-mode project. Upon approval of the Project Plan, the unique project organization and management roles will have been established and approved.

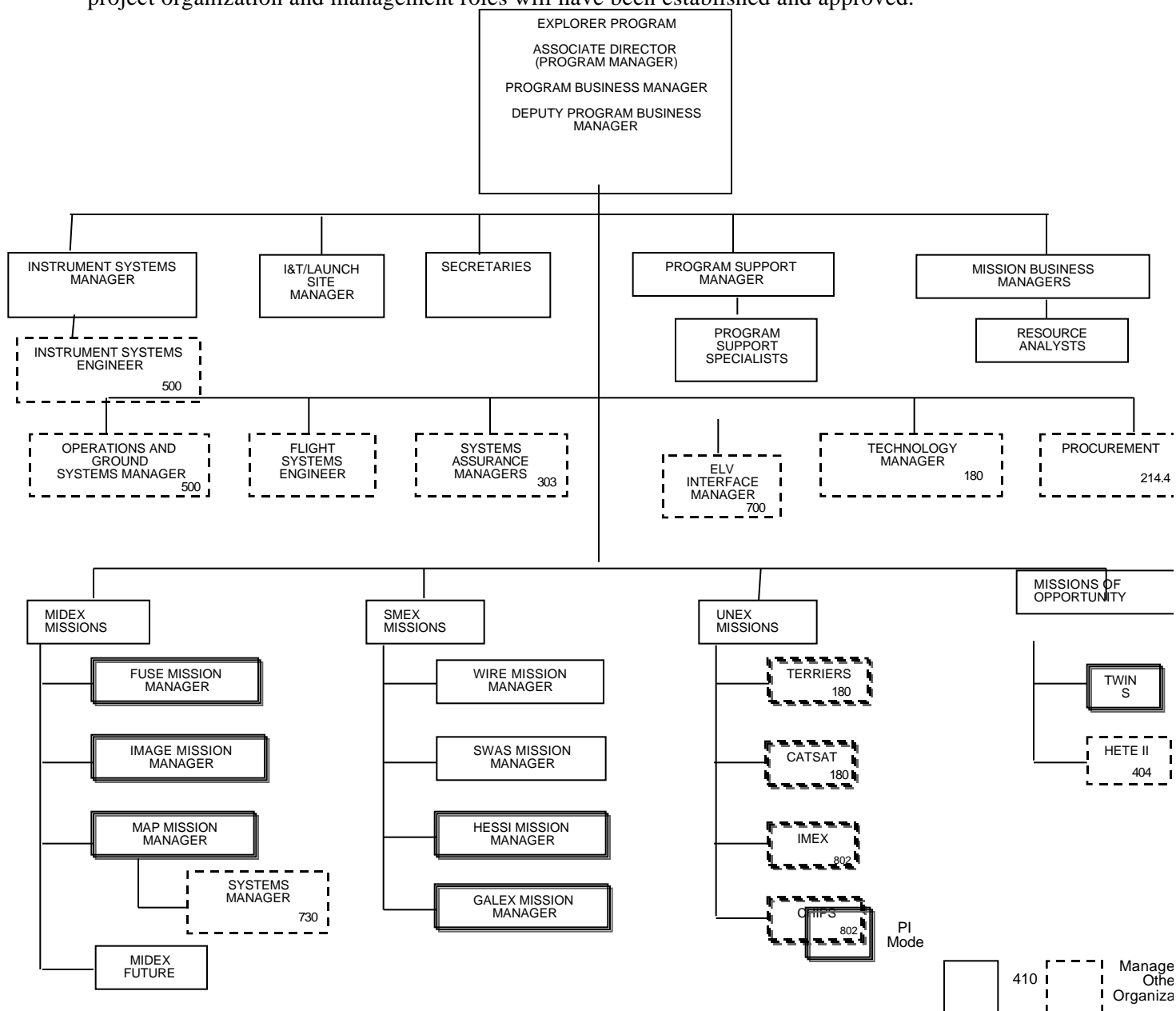


Figure 3-7b. Sample GSFC Program/Project Organization including PI Projects

3.2.3.2.1 Senior Project Management

- a. The roles of the Project Manager and Project Scientist are defined in paragraphs 3.2.1.3 and 3.2.1.4.
- b. Deputy Project Manager – The Deputy Project Manager is responsible to the Project Manager and is an integral member of the management team for the project. He/she supports the Project Manager in directing all phases of the project, and has project-wide responsibility for planning and evaluating all project activities on a day-to-day basis. He/she provides technical management to the team of technically skilled specialists and their supporting personnel in order to meet performance cost and schedule commitments. In the absence of the Project Manager, the DPM assumes full responsibility for project management.
- c. Deputy Project Manager for Resources – The Deputy Project Manager for Resources is responsible to the Project Manager and is an integral member of the management team for the project. He/she contributes business management expertise to the establishment of technical program/project objectives and is responsible for the application of business and financial management techniques to the accomplishment of project objectives. The Deputy Project Manager/Resources manages a team of specialists in the areas of finance, budget, procurement, scheduling, pricing, configuration management, QMS management, etc., and is responsible for the application of sound business techniques to the accomplishment of project objectives. In the absence of the Project Manager and the Deputy Project Manager, the Deputy Project Manager for Resources acts for the Project Manager.

3.2.3.2.2 Systems Assurance Manager The Systems Assurance Manager (SAM), from the Office of System Safety and Mission Assurance (OSSMA) (Code 300), is responsible for coordination of and follow-up on the System Safety and Mission Assurance disciplines for the project to ensure that the flight system and ground data systems will meet intended performance objectives. These disciplines include reliability, quality assurance, design review, system safety, range safety and requirements definition, and environmental testing.

3.2.3.2.3 Mission System Engineer The Mission System Engineer (MSE) is responsible for optimizing all systems aspects of the flight and ground segments. He/she is responsible for developing the systems design of the flight segment and for ensuring that it is compatible with the scientific instruments, launch vehicle, communications system, ground segment, reliability objectives, and end products. He/she establishes interface constraints and requirements for subsystems, resolves interface and system-level performance questions and problems, reviews and approves for manufacture the electrical/mechanical flight hardware designs, and oversees the electrical/mechanical integration and test of the spacecraft. He/she reviews performance data and measurements throughout the project to ensure that flight and ground segments meet stated requirements and objectives including verification and validation of scientific end-products and services.

Specifically, the MSE has review and sign-off responsibilities for all major system-level functional performance and design specifications; he/she performs risk assessments and evaluates design margins and adequacies; reviews all major test plans and procedures; compares predicted and actual performance of the system; reports routinely to the Project Manager on the status of system engineering activities; serves as chairperson for major failure review committees, and advises the Project Manager as to major critical aspects of his/her assignment. He/she is responsible for suggesting the use of new technical approaches to the project after having determined the risk involved.

3.2.3.2.4 Software Systems Manager -- The Software Systems Manager is responsible for the integrity of the total software systems used on the project. Typically reporting to the MSE, he/she supports the Project Manager by monitoring and overseeing the Flight, Integration and Test, Ground Support Equipment (GSE), Reliability-based Logistics, Ground Operations, Ground Data

Processing Software Systems, their respective interfaces, the scientific investigators, interfaces and their interfaces to the scientific community. He/she puts particular emphasis on the project outputs' usefulness to the whole scientific community and other probable users. Software personnel within the specific functional organization they are supporting develop individual software systems. The existence of this position in a project is dependent upon project needs.

3.2.3.2.5 Mission Manager The Mission Manager from Networks and Mission Services Project (Code 450) is responsible for the development of the Project Service Level Agreement (PSLA), which contains operational ground system requirements. As a member of the Code 450 staff, he/she is responsible for the SOMO-provided operational ground system support integrity, including defining project requirements and overseeing the development of the complete operational ground system. As documented in the PSLA, before launch the Mission Manager is responsible for interfacing with SOMO and ensuring that operational requirements are achieved, including all necessary tests and validations of the operating system. After launch, he/she is responsible for the operation of the spacecraft to fulfill the mission objectives, including production of scientific data and end-item services.

3.2.3.2.6 Ground System Project Manager (GSPM) The GSPM is responsible for the development of the data processing ground system. As a member of the project staff, matrixed from Information Systems (Code 580), he/she is responsible for the total data processing ground system support integrity, including converting and interpreting requirements from the Experiment/Instrument Systems Manager and overseeing the development, test, and evaluation of the complete data processing ground system. The data processing ground system consists of all of the necessary hardware, software, communications support, and required facilities necessary to produce an acceptable data set for the experimenter/instrumenter/user/customer.

3.2.3.2.7 Spacecraft/Observatory Manager The Spacecraft/Observatory Manager marshals and directs the efforts of a team of government and industry specialists in identifying and specifying the mission-imposed spacecraft/observatory requirements, in developing subsystems and systems capable of fully meeting those requirements, and in demonstrating that the spacecraft/observatory and its components meet its functional performance goals in the launch and space environments. He/she ensures that the infrastructure, facilities, tools, fixtures, test equipment, and Automated Data Processing (ADP) hardware and software required in the fabrication, assembly, integration, and test of the subsystems and of the spacecraft/observatory are procured or developed and are available at the appropriate times and places. The Spacecraft/Observatory Manager is responsible for planning and managing these tasks so that they are completed on schedule and within the available resources. In an out-of-house project, he/she is the Contracting Officer's Technical Representative (COTR) for the observatory contract.

3.2.3.2.8 Payload Manager (Instrument Systems Manager (ISM)) The Payload Manager, or Instrument Systems Manager, is responsible for close liaison and monitoring of the instrument development or other types of payload hardware development being performed by other GSFC directorates or outside GSFC, by universities and contractors. He/she must ensure through coordination and technical review of the payload designs that the instruments or payload hardware meet the technical performance, cost and schedule parameters for the basic mission requirements. He/she is responsible for coordinating the spacecraft bus/payload interfaces and for providing the related Ground Support Equipment (GSE), and for assuring that scientific algorithm development, in conjunction with the Project Scientist, is completed in a timely manner.

3.2.3.2.9 Procurement Manager The Procurement Manager works closely with and supports the Deputy Project Manager/Resources, and is responsible for all major procurement functions of the project, including planning, directing, coordinating, and evaluating all project procurement activities in accordance with the Project Plan, NASA policies and Goddard QMS requirements.

3.2.3.2.10 Financial Manager The Financial Manager is a member of the business support team and reports to the Deputy Project Manager/Resources. He/she is responsible for the application of sound financial management principles in the areas of cost control, financial analysis, EVM evaluation and assessment, budget preparation and execution, pricing, and support of Project QMS management.

3.2.3.2.11 Project Support Manager The Project Support Manager is a member of the business support team and reports to the Deputy Project Manager/Resources. He/she is responsible for scheduling, configuration management, manpower analysis, property management and control, life cycle logistics coordination, Management Information Systems (MIS), personnel safety, and other general administrative and overall project planning activities including Goddard QMS management.